

AURORAS OBSERVED DURING AUGUST, 1916.

AURORA OF AUGUST 26, 1916.

On referring to Wolfer's tables of relative sun-spot numbers¹ it is at once evident that during 1916-17-18 the solar system is again entering upon a period of maximum frequency of sun spots. Accordingly it is not surprising to find the aurora of increasingly frequent occurrence and of greater beauty and extent.

Up to the date of writing, the most extensive and gorgeous display of this year occurred on the night of August 26-27; as the following reports will show, this aurora has been reported from England, eastern and western United States, and occurred simultaneously at those and intermediate points. No doubt in time we shall hear of its appearance at many other points also. Readers will recall that the aurora of June 17, 1915, was visible simultaneously from Canadian stations down to Dunedin, New Zealand.² Next month it is hoped to present a map of the visibility of the aurora of August 26, 1916, for the United States, based on reports from Weather Bureau stations and the cooperative observers.

Table 1 presents a list of the regular Weather Bureau stations and shows at which stations the aurora was observed, while the reference number preceding the station name refers to the appropriate description given on following pages. Certain special reports by correspondents appear independently (p. 444).

TABLE 1.—Index to Weather Bureau stations reporting the aurora of Aug. 26-27, 1916.

(Numbers refer to description on pp. 440-443.)

Ref.	Station.	Obs.	Ref.	Station.	Obs.
.....	Abilene, Tex.	.....	12	El Paso, Tex.	.....
.....	Albany, N. Y.	.....	26	Erie, Pa.	.....
19	Alpena, Mich.	.....	.....	Escanaba, Mich.	.....
.....	Amarillo, Tex.	.....	.....	Eureka, Cal.	.....
.....	Anniston, Ala.	.....	.....	Evansville, Ind.	.....
.....	Asheville, N. C.	.....	.....	Fort Smith, Ark.	.....
.....	Atlanta, Ga.	.....	.....	Fort Wayne, Ind.	.....
.....	Atlantic City, N. J.	.....	.....	Fort Worth, Tex.	.....
.....	Augusta, Ga.	.....	.....	Fresno, Cal.	.....
60	Baker, Oreg.	.....	.....	Galveston, Tex.	.....
.....	Baltimore, Md.	.....	.....	Grand Forks, N. Dak.	.....
.....	Bentonville, Ark.	.....	21	Grand Haven, Mich.	.....
.....	Billings, Mont.	.....	.....	Grand Junction, Colo.	.....
.....	Binghamton, N. Y.	.....	22	Grand Rapids, Mich.	.....
.....	Birmingham, Ala.	.....	25	Green Bay, Wis.	.....
42	Bismarck, N. Dak.	.....	.....	Hannibal, Mo.	.....
4	Block Island, R. I.	.....	.....	Harrisburg, Pa.	.....
61	Boise, Idaho.	.....	.....	Hartford, Conn.	.....
.....	Boston, Mass.	.....	.....	Hatteras, N. C.	.....
1	Burlington, Vt.	.....	52	Hayre, Mont.	.....
.....	Cairo, Ill.	.....	53	Helena, Mont.	.....
5	Canton, N. Y.	.....	.....	Honolulu, Hawaii.	.....
.....	Cape Henry, Va.	.....	26	Houghton, Mich.	.....
36	Charles City, Iowa.	.....	.....	Houston, Tex.	.....
.....	Charleston, S. C.	.....	44	Huron, S. Dak.	.....
.....	Charlotte, N. C.	.....	.....	Indianapolis, Ind.	.....
.....	Chattanooga, Tenn.	.....	.....	Iola, Kans.	.....
.....	Cheyenne, Wyo.	.....	59	Jacksonville, Fla.	.....
23	Chicago, Ill.	.....	.....	Kalispell, Mont.	.....
16	Cincinnati, Ohio.	.....	32	Kansas City, Mo.	.....
13	Cleveland, Ohio.	.....	.....	Keokuk, Iowa.	.....
.....	Columbia, Mo.	.....	.....	Key West, Fla.	.....
.....	Columbia, S. C.	.....	37	Knoxville, Tenn.	.....
14	Columbus, Ohio.	.....	.....	La Crosse, Wis.	.....
.....	Concord, N. H.	.....	17	Lander, Wyo.	.....
.....	Concordia, Kans.	.....	.....	Lansing, Mich.	.....
.....	Corpus Christi, Tex.	.....	.....	Leadville, Colo.	.....
33	Dallas, Tex.	.....	.....	Lewiston, Idaho.	.....
.....	Davenport, Iowa.	.....	.....	Lexington, Ky.	.....
.....	Dayton, Ohio.	.....	.....	Lincoln, Neb.	.....
.....	Del Rio, Tex.	.....	.....	Little Rock, Ark.	.....
34	Denver, Colo.	.....	20	Los Angeles, Cal.	.....
.....	Des Moines, Iowa.	.....	11	Louisville, Ky.	.....
41	Detroit, Mich.	.....	.....	Ludington, Mich.	.....
.....	Devils Lake, N. Dak.	.....	30	Lynchburg, Va.	.....
.....	Dodge City, Kans.	.....	.....	Macomb, Ga.	.....
.....	Drexel, Neb.	.....	.....	Madison, Wis.	.....
35	Dubuque, Iowa.	.....	27	Manatee, N. Y.	.....
40	Duluth, Minn.	.....	.....	Marquette, Mich.	.....
.....	Eastport, Me.	.....	.....	Memphis, Tenn.	.....
.....	Elkins, W. Va.	.....	.....	Meridian, Miss.	.....
.....		.....	.....	Miami, Fla.	.....

¹ MONTHLY WEATHER REVIEW, July, 1915, 43: 314-5.
² MONTHLY WEATHER REVIEW, 1915, 43: 445, 546, 596.

TABLE 1.—Index to Weather Bureau stations reporting the aurora of Aug. 26-27, 1916—Continued.

(Numbers refer to description on pp. 440-443.)

Ref.	Station.	Obs.	Ref.	Station.	Obs.
51	Miles City, Mont.	.....	.....	St. Louis, Mo.	.....
24	Milwaukee, Wis.	.....	39	St. Paul, Minn.	.....
39	Minneapolis, Minn.	.....	.....	Salt Lake City, Utah.	.....
.....	Mobile, Ala.	.....	.....	San Antonio, Tex.	.....
56	Modena, Utah.	.....	.....	San Diego, Cal.	.....
.....	Montgomery, Ala.	.....	.....	Sand Key, Fla.	.....
43	Moorhead, Minn.	.....	.....	Sandusky, Ohio.	.....
.....	Mount Tamalpais, Cal.	.....	.....	Sandy Hook, N. J.	.....
.....	Nantucket, Mass.	.....	.....	San Francisco, Cal.	.....
.....	Narragansett Pier, R. I.	.....	.....	San Jose, Cal.	.....
.....	Nashville, Tenn.	.....	.....	San Juan, Porto Rico, W. I.	.....
.....	New Haven, Conn.	.....	.....	San Luis Obispo, Cal.	.....
.....	New Orleans, La.	.....	18	Santa Fe, N. Mex.	.....
.....	New York, N. Y.	.....	.....	Sault Sainte Marie, Mich.	.....
.....	Norfolk, Va.	.....	.....	Savannah, Ga.	.....
2	Northfield, Vt.	.....	62	Scranton, Pa.	.....
.....	North Head, Wash.	.....	.....	Seattle, Wash.	.....
.....	North Platte, Nebr.	.....	.....	Sheridan, Wyo.	.....
.....	Oklahoma, Okla.	.....	.....	Shreveport, La.	.....
47	Omaha, Nebr.	.....	46	Sioux City, Iowa.	.....
6	Oswego, N. Y.	.....	58	Spokane, Wash.	.....
.....	Palestine, Tex.	.....	.....	Springfield, Ill.	.....
15	Parkersburg, W. Va.	.....	.....	Springfield, Mo.	.....
.....	Pensacola, Fla.	.....	7	Syracuse, N. Y.	.....
31	Peoria, Ill.	.....	63	Tacoma, Wash.	.....
.....	Philadelphia, Pa.	.....	.....	Tampa, Fla.	.....
.....	Phoenix, Ariz.	.....	.....	Tatoos Island, Wash.	.....
.....	Pierre, S. Dak.	.....	.....	Taylor, Tex.	.....
.....	Pittsburg, Pa.	.....	.....	Terre Haute, Ind.	.....
55	Pocatello, Idaho.	.....	.....	Thomasville, Ga.	.....
.....	Point Reyes Light, Cal.	.....	.....	Toledo, Ohio.	.....
.....	Port Angeles, Wash.	.....	.....	Tonopah, Nev.	.....
.....	Port Huron, Mich.	.....	49	Topeka, Kans.	.....
.....	Portland, Me.	.....	.....	Trenton, N. J.	.....
.....	Portland, Oreg.	.....	50	Valentine, Neb.	.....
3	Providence, R. I.	.....	.....	Vicksburg, Miss.	.....
.....	Pueblo, Colo.	.....	.....	Wagon Wheel Gap, Colo.	.....
.....	Raleigh, N. C.	.....	59	Walla Walla, Wash.	.....
.....	Rapid City, S. Dak.	.....	9	Washington, D. C.	.....
.....	Reading, Pa.	.....	29	Wausan, Wis.	.....
.....	Red Bluff, Cal.	.....	.....	Wichita, Kans.	.....
.....	Reno, Nev.	.....	.....	Williston, N. Dak.	.....
10	Richmond, Va.	.....	.....	Wilmington, N. C.	.....
8	Rochester, N. Y.	.....	.....	Winnemucca, Nev.	.....
.....	Roseburg, Oreg.	.....	.....	Wytheville, Va.	.....
.....	Roswell, N. Mex.	.....	45	Yankton, S. Dak.	.....
.....	Sacramento, Cal.	.....	54	Yellowstone Park, Wyo.	.....
.....	Saginaw, Mich.	.....	.....	Yuma, Ariz.	.....
48	St. Joseph, Mo.	.....	.....

† Described under number given.
 * Recorded but not described.
 .. Not observed at that station.

Reports from Weather Bureau stations.

In the following extracts the standard time used at the station is given in curves immediately after the name of the station. Geographical coordinates of the stations can be found in "Report of the Chief of the Weather Bureau, 1913-14," Table I, pages 30-34.

1. *Burlington, Vt.* (75th mer.), August 26, 1916.—Aurora first observed at 9:50 p. m. consisted of narrow grayish arch; azimuth from 165° to 195°. Altitude of arch at highest point about 20°. Numerous streamers observed, some shooting to zenith. The display was unusually brilliant, but of short duration. Ended at 10:20 p. m.

2. *Northfield, Vt.* (75th mer.).—Auroras were observed on the 26th and 28th.

3. *Providence, R. I.* (75th mer.), August 26, 1916.—The only optical or electrical phenomenon, aside from lightning, observed during the month was an aurora during the night of the 26th. The display was not observed by any member of the station force, but was reported from various sources, believed to be reliable, to have been of exceptional brilliancy.

4. *Block Island, R. I.* (75th mer.), August 26, 1916.—An auroral display was observed from 8 p. m. to 10 p. m. The altitude of the arch was about 20°, and the azimuth extended from about 120° to 220°. There were lively streamers of pale green ascending from a few degrees below the arch to an altitude of about 45°. The whole display was very brilliant.

5. *Canton, N. Y.* (75th mer.), August 26, 1916.—Faint auroral arch and streamers 8 to 10 p. m.; obscured partly by clouds.

6. *Oswego, N. Y.* (75th mer.), August 26, 1916.—An unusually brilliant auroral display was visible from 8 p. m. until after 10:45 p. m. The light was devoid of coloring, except near the horizon, where a reddish tint was noticeable. The extent of the display, reaching as it

did from west to east and from the horizon to south of the zenith, and its intense activity were the features. Broad waves of whitish light flashed incessantly from the horizon up to and past the zenith, but there was practically no lateral movement. It is seldom that such rapid movement of the waves of light is seen.

7. *Syracuse, N. Y.* (75th mer.), August 26, 1916.—An aurora was reported to have been visible from 8 to 10 p. m.

8. *Rochester, N. Y.* (75th mer.), August 26, 1916.—An aurora which occurred on the 26th is excellently described in the following article from the "Democrat and Chronicle," by Prof. Latimer J. Wilson, in charge of the Bausch & Lomb Observatory:

"From shortly after dark until 9:30 o'clock last Saturday evening an aurora of unusual brilliance spread across the entire northern sky and extended as far as the constellation Sagittarius in the south. Observations made at the Bausch & Lomb Observatory disclosed several extraordinary features attending the display.

"The first sign of anything out of the ordinary in the heavens was a very noticeable glow in the northeast and peculiar horizontal streaks of what at first appeared to be thin clouds of haze directly overhead. A moment's consideration showed that the haze was subject to the most remarkable changes. It looked somewhat as though a battery of small searchlights were trained upon the overhead part of the sky, striking through the haze and lighting it with slender or broad beams of pale light. The beams came from the northeast, the northwestern section of the sky being covered by a large gray cloud. The cloud drift seemed generally in a northeasterly direction and was rather rapid.

"Notwithstanding the brilliance of the phenomenon, probably few city people saw it because of the glare of the street lights. A keen observer stepping into a dark corner of his lawn where shrubbery screened the electric lights from his eyes would have seen the background of the aurora, glowing between the breaks in the northern cloud covering. Perhaps the brightest part of the phenomenon occurred at 9 o'clock, when the clouds which had hidden the north and northwestern part of the heavens began to clear away in places.

"The effect was very similar to bright moonlight streaming in crepuscular rays from between the clouds. A continuous shifting of the rays betrayed their auroral origin. Pulsations of rosy light flashed across the apparently low masses of haze. These masses were quite distinct from the small cloud groups which resembled cirrus forms and which were drifting somewhat less rapidly toward the northeast. The vaporous accumulations upon which the aurora was discerned grew very bright for a few minutes, and ribbons of the rosy light waved across them in the form of an arc."

9. *Washington, D. C.* (75th mer.), August 26, 1916.—An aurora, brilliant at intervals, was reported to have been observed from 9 p. m., August 26, to 12:45 a. m., August 27. It was from 3° to 5° in width, with pulsating shafts of light, or "merry dancers," extending upward to the zenith.

10. *Richmond, Va.* (75th mer.), August 26, 1916.—An aurora borealis was observed on the evening of the 26th.

11. *Lynchburg, Va.* (75th mer.), August 26, 1916.—Aurora observed to-night. [No details given.]

12. *Erie, Pa.* (75th mer.), August 26, 1916.—A pronounced auroral display occurred from about 11 p. m. until midnight. The streamers reached clear to the zenith and somewhat resembled the rays from a powerful searchlight. Telegraphic reports indicate that it was observed as early at 7 p. m. in other cities, but local cloudiness prevented its observation that early. It attained its greatest development about midnight. The altitude of the crown was about 20°, while the extremity of the streamers was 90°. The azimuth was about 110° to 250°.

13. *Cleveland, Ohio* (75th mer.), August 26, 1916.—At 9 p. m. a telephone message from Cleveland Heights called attention to the presence of "searchlights" in the north. At station no lights of this description could be seen in that or any other direction. However, from reliable information received from other sources in the city's suburbs, it is evident that an auroral display of short duration took place.

14. *Columbus, Ohio* (90th mer.), August 26, 1916.—An aurora was observed to-night.

15. *Parkersburg, W. Va.* (75th mer.), August 26, 1916.—During the evening an aurora was observed, but on account of cloudiness observations were made at short intervals only.

16. *Cincinnati, Ohio* (90th mer.), August 26, 1916.—A glow of light was observed in the northeast from 8:55 p. m. to 9:15 p. m., being brightest about 9:05 p. m. The light appeared to be from the aurora borealis, but was not distinct enough to make definite observations. At 9:05 p. m. a bright streak of light extended from 10° south of the zenith to near the western horizon. This appeared to be a cloud formation and disappeared rapidly within two or three minutes.

17. *Lansing, Mich.* (90th mer.), August 26, 1916.—A brilliant aurora was observed to-night between 10 and 12 p. m.

18. *Sault Ste. Marie, Mich.* (90th mer.), August 26, 1916.—Aurora visible from 7:25 p. m., ending about 11:15 p. m. At 7:40 p. m. until 8 p. m. the display was like a cirro-stratus veil, covering the entire sky, waving back and forth at short intervals. Neither arch nor colors were observed.

19. *Alpena, Mich.* (90th mer.), August 26-27, 1916.—Beginning on the evening of the 26th and continuing into the morning of the 27th, one of the most magnificent, and to many awesome, auroral displays ever observed at this station was witnessed. It was first noticed just after dark in the east. As darkness came on a great band of straw-colored light appeared across the firmament from east to west, spreading 40° north of the zenith and 10° south. This band of light had a steady movement to the southern horizon and reached it in about 20 minutes. By this time the whole heavens were covered with a sheet of whitish light which was bright and steady. Shortly this broke up into patches of iridescent light, which formed and vanished with tremendous speed in all parts of the heavens. Occasionally these patches were of indescribably fantastic shapes, joining and spreading to the zenith, forming a dome. The southern horizon was as bright as the northern. The display continued with irregular grandeur until some time after 2 a. m. Many people who were on Lake Huron spoke of the beautiful reflection of the display from the water.

20. *Ludington, Mich.* (90th mer.), August 26, 1916.—Brilliant aurora beginning about 8 p. m. and continuing practically all night until about 4 a. m. [of August 27]. Definite observations were continued until nearly midnight. No distinct arch was observed, although clouds in the north-north-east of the evening would have obscured the arch had one existed. The display consisted mainly of whitish and yellowish sheets, streaks, bands, and rays at places all along the north, east, and west quarters of the horizon and up to the zenith and far beyond [toward] the south. At times pronounced flashing occurred, especially in the northeast and northwest and in addition to whitish and yellowish, reddish, greenish, and violet colors appeared. At about 10:45 to 11 o'clock a pronounced rosette or crystal-like formation was observed overhead at about 10° southeast of the zenith; it had a dark center and whitish streaks fully 10° to 15° long radiating in every direction. One or more similar formations are said to have occurred earlier in the evening. At about 10 o'clock a whitish band spanned the sky from east to west nearly through the zenith, and dark streaks at intervals of about 30° stretched from the band toward the south. However, nearly all the sheets and streaks during the display were vertical and from north to south.

21. *Grand Haven, Mich.* (90th mer.), August 26, 1916.—Streamers of light, apparently from aurora light, played over about seven-tenths of the sky above the horizon beginning between 7 and 8 p. m., and continuing to nearly midnight.

22. *Grand Rapids, Mich.* (90th mer.), August 26, 1916.—The aurora of to-night was very brilliant and lasted from dark till near midnight. While no color was observed it was as brilliant as a powerful searchlight, the beams frequently attaining the zenith and traveled in curtain-like waves very rapidly from west to east, dimming and glowing at frequent intervals. Its base was a dark arch extending about 10° above the horizon. Its influence was first felt by wire companies about 5 p. m., and from that time up to near midnight telegraph and telephone service, especially east and west, was interrupted, and at times almost suspended. Azimuth 90° to 225°, altitude 90°.

23. *Chicago, Ill.* (90th mer.), August 26, 1916.—A very brilliant display of the aurora borealis was seen to-night. The aurora began about 7:30 p. m. and continued until after 11 p. m. The whitish arc of light could be plainly seen in the north and the quivering, rapid-moving beams of light extended almost to the zenith. It was reported that telephone and telegraph transmission was slightly affected north and east of Chicago.

24. *Milwaukee, Wis.* (90th mer.), August 26, 1916.—An auroral display was observed to-night from 8:30 p. m. to about midnight. There seemed to be no well-defined ray of light but the whole sky from west to north seemed to be lit up with light waves that rose and receded like the flames of a fire. It interfered somewhat with telegraphic communication.

25. *Green Bay, Wis.* (90th mer.), August 26, 1916.—Aurora 26-27th, first observed at 8:50 p. m. and continued to 12 midnight. First appeared as flashing streamers of white light, from about 15° above the horizon to the zenith, and extending from about 90° to 200° azimuth; between 135° and 160° the aurora was partly obscured by a dark bank of clouds. From 10:40 p. m. to midnight the streamers appeared to be shooting from all directions [toward] a point near the zenith, and forming a brilliant corona; the streamers appeared broader and more clearly defined on the north and west sides. It became less active after 12 midnight and disappeared at 12:45 a. m. of the 27th.

26. *Escanaba, Mich.* (90th mer.), August 26, 1916.—An auroral display was observed at 7:45 p. m. The phenomenon invested almost the entire sky, and seemed to be centered directly overhead, giving

the appearance of a vast parasol. The light waves pulsed in concentric rings which gradually were drawn in toward the center, intensifying its brightness. An arch of about 10° altitude, and about 135° to 225° in azimuth was plainly marked across the northern horizon. Greenish light predominated with an occasional tinge of red. It is reported that the phenomenon continued well after midnight, though it was not under the observation of the observer after 9 p. m.

27. *Marquette, Mich.* (90th mer.), August 26, 1916.—A sky-covering, beautiful silver-colored aurora was seen by all on the 26th.

28. *Houghton, Mich.* (90th mer.), August 26, 1916.—Aurora observed to-night, consisting of a greenish arch about 30° in altitude and 60° in azimuth; from this arch various-colored and rapidly moving streamers reached beyond the zenith. The display lasted for nearly two hours.

29. *Wausau, Wis.* (90th mer.), August 26, 1916.—A very brilliant aurora was observed from 8:15 to 11:30 p. m. At 8:25 p. m. the aurora became very brilliant and, as near as could be seen, came from every quarter of the horizon. The sheets of light shot upward until they met in the zenith, forming there sometimes three and at other times a four pointed star. This star had the appearance of being formed of bright cirrus clouds. In looking toward the zenith one had the impression of looking up into a gigantic dome. This ended about 8:50 p. m., but several displays of nearly equal brilliance occurred several times during the evening. The entire northern sky remained brilliant until about 11:30 p. m. when [the light] waned.

30. *Madison, Wis.* (90th mer.), August 26, 1916.—An unusually brilliant aurora observed from dark. Many streamers rising from auroral arch in north. Draperies overhead and in east shimmered and flashed, the change being very rapid. No color observed. . . . Aurora of the 26th probably visible to about 2 a. m. of the 27th.

31. *Peoria, Ill.* (90th mer.), August 26, 1916.—A striking display of aurora borealis, composed of glow and streamers with considerable drifting, flashing, dancing, and flickering. Coloring generally whitish with a little rainbow tinting about 9 to 9:15 p. m. A noticeable drifting from about east-northeast and at the same time a southward shift of the whole formation. About 10 p. m. the front or higher portion of white streamers had formed a sort of band near the zenith, extending from about azimuth 95° to azimuth 280°, while the display farther north had decreased in brilliance. (Perhaps this band-like appearance was due to perspective of streamers standing nearly vertical in the sky.) Later the band formation shifted 10° or 15° south of the zenith, retaining its original trend. A westward drift within the band was at all times noticeable, but the band at no time reached lower in the west than altitude 40°.

32. *Kiokuk, Iowa* (90th mer.), August 26, 1916.—Aurora first observed at 8:30 p. m., arch extending from northwest to northeast, color changing between red and green, streamers shooting up to about 30° above the horizon, in the center of the arch, and undulating horizontally.

At 9 p. m. a peculiar band of grayish color, resembling thin stratus cloud, was observed. Band at an elevation of about 45° above the southern horizon, some 3° in width, reached across the sky, which was perfectly clear, from near the western to near the eastern horizon. This band was still plainly visible at 11 p. m. The aurora was brightest between 11 p. m. and midnight.

33. *Davenport, Iowa* (90th mer.), August 26, 1916.—An aurora, which was first observed at 8:40 p. m., prevailed until after midnight. A pale yellow glow, resembling the reflected light over a large city, extended upward to about 5° south of the zenith. No arch was observed.

34. *Des Moines, Iowa* (90th mer.), August 26, 1916.—A rather well-defined aurora borealis was observed at night. The illumination was first noted about 8:30 p. m., and it was still in evidence at 11 p. m. The most pronounced feature of the display was the flashing of the streamers; these at times extended upward well toward the zenith. About 9 p. m., as the display became less intense for a time, a whitish appearing arc or band of light was noted extending across the sky almost from horizon to horizon, from a point a little north of west to a point a little south of east. When first seen, the crown or top of the arc was almost overhead; but the whole arc drifted southward, and by 9:15 p. m. had disappeared. At the time of disappearance the top of the arc was probably 25° south of the zenith. The width of the arc was rather uniform throughout its length, being about 2°.

35. *Dubuque, Iowa* (90th mer.), August 26, 1916.—The finest aurora borealis witnessed at this station in many years occurred to-night. It began in the early evening and lasted several hours (first observed by the writer at about 7:30 p. m., was most brilliant around 8:30 p. m., and was faint after 9:30 p. m.). Consisted of quivering white beams which came out of the north. These beams were distinct and reached to the zenith and about 10° or 15° beyond. The entire northern half of the sky was bright, and from the horizon to about 30° above the sky was greenish, resembling a curtain. The most distinct green was in the extreme north. The display overhead was beautiful, there being numerous patches of quivering light.

36. *Charles City, Iowa* (90th mer.), August 26, 1916.—An auroral display observed from 7:48 p. m. until midnight. When it was first no-

ticed, there was a light-gray arch: its base extended from 135° to 225° azimuth, the crown reaching 20° altitude. The arch disappeared at 8:20 p. m. From about 8:20 p. m. until 11:40 p. m. there appeared streaks and groups of white to gray in color, the former resembling "mares' tails," the latter denser cirri formations. These lights or groups of lights at times filled the sky from the zenith down to the horizon between 110° and 230° azimuth: again there would be only one or two "mares' tails," but always each separate formation seemed to emit light waves which flickered and drifted from their sources. At the same time there appeared stronger shafts of light, much like electric headlights when seen from a distance at right angles to the rays. These did not always originate in any of the formations, generally first appearing at points where the blue sky could be distinguished. Usually these "headlight" shafts moved up toward the zenith, but some of them were extended at angles to that direction. When extended to their full length, they remained stationary for a short time: then the shaft began fading at the point in the sky where it originated, gradually shortening until the outward, or upward, end was the last seen of it. This characteristic shortening made the shaft appear to drift away from its source. When the sky was well filled, within the limit stated, the combined light from the different sources was near that of the full moon. In unlighted rooms with open windows people and objects on the other side of the street were reflected from mirrors.

Several cirri formations were observed during the afternoon and 4/0 Ci. was recorded at the 7 p. m. observation. The resemblance to those clouds noted in the auroral display may have been due to their presence at that time and illumination. However, a careful watch was maintained for them when the intervening light was weak enough to permit seeing the blue beyond it, and no clouds were seen: also, had they been in that zone it is likely some would have been in other sections of the sky, and there was no display elsewhere.

37. *La Crosse, Wis.* (90th mer.), August 26, 1916.—An unusually brilliant auroral display was observed during the evening of the 26th and the morning of the 27th. At 8:30 p. m. of the 26th northern-lights streamers were observed above the northwestern horizon. By 9 p. m. the sky was nearly covered by quivering rays or beams, which continued with varying degrees of brilliancy after midnight. The display caused considerable excitement on account of its extent and its brilliant flashing and darkening.

I have not heard of any person who claims to have seen a display of such extent and brilliancy. One man thought it a searchlight playing over the sky, and a little girl was overheard calling, "Mother, come out and see the lightning all over the sky."

38. *Minneapolis, Minn.* (90th mer.), August 26, 1916.—An unusual auroral display was observed beginning shortly after 8 p. m. It then covered the northern half of the sky from azimuths 80° to 280°. The display took on several forms. There were several more or less well-defined arches in the north-northeast, with streaks and streamers pointing upward from the east, north, and west and converging at a central point or apex about 10° south of the zenith, where the streaks of light were of shorter length and arranged themselves around this apex similar to pieces of iron filings in a field of magnetic force. There were also patches of irregular cloudlike masses of light scattered over the northern sky. Very few of the streamers had any "shooting" upward motion, but there was a continuous wavelike motion from all sides toward the apex running over the light places and streaks. The display continued until after 12 midnight with varying intensity. There were no eastward-westward motions along the arches and very little coloring.

39. *St. Paul, Minn.* (90th mer.), August 26, 1916.—There was a fine auroral display from about 8 p. m. to near midnight. As noted by the official in charge, at 8 p. m. it extended from about azimuth 60°, by the north to about azimuth 270°, extending to about altitude 85°, as streamers of whitish light, with occasional rose tints. At about 8:25 p. m. a green tint in streamers about 40° high, near azimuth 200°; the display quickly extended over the sky to near the southern horizon, with an apex slightly south of the zenith.

The display constantly varied, with dancing waves of light alternating with streamers near the western to north of the eastern horizon. The center of the display appeared to be near azimuth 180°. No dark segment could be distinguished prior to 10 p. m., nor at intervals until near midnight.

40. *Duluth, Minn.* (90th mer.), August 26, 1916.—A very brilliant aurora observed about 10 p. m. from azimuth 150° to about azimuth 225°. The altitude of the highest shafts of light was about 60°. These perpendicular shafts were of a greenish white color and moved back and forth horizontally, giving the appearance of a waving curtain.

41. *Devils Lake, N. Dak.* (90th mer.), August 26, 1916.—The * * * aurora was a magnificent display of large proportions. It was first observed at 9 p. m. and was still [pulsating] at 11:30 p. m. Its position was unusual, spanning the southern sky at high altitude, its center nearly reaching the zenith. Its azimuth was about 60° to 270°. The colors were of great variety, the more predominant ones being pale green, violet, and purple.

42. *Bismarck, N. Dak.* (90th mer.), August 26, 1916.—Aurora observed from 10 p. m. to midnight; an unusually brilliant display, covering almost the whole sky from 11 p. m. to midnight.

43. *Moorhead, Minn.* (90th mer.), August 26, 1916.—An aurora of unusual brilliancy was seen. As first observed at 9:25 p. m. it consisted of a diffused light over the west and northwest, with faint streamers reaching to the zenith. Objects were visible as by moonlight. At 11 o'clock p. m. the observer was awakened by violent ringing of the doorbell by two men who seemed terrified and asked for an explanation of the wonderful light in the heavens. The whole sky was illuminated with streamers and waves of light moving very rapidly from west to southwest, with the whole northern sky as brilliant as a clear sunrise, just before the sun appears. This phenomenon extended over the whole sky and was indescribably grand and awe inspiring. The display lasted until about midnight, when it gradually disappeared.

The following is quoted from the *Moorhead Daily News* of Monday, August 28, 1916: "For several hours Saturday night one of the most brilliant auroræ ever witnessed at this period of the year was seen in Moorhead. Great spires of light extended from the horizon and stabled the heavens like sheets of flame.

"For sometime the center of the display was directly overhead, from which luminous streamers extended in all directions, some of the shafts ending in great patches of light that shimmered and fluctuated like the flames of a great conflagration.

"* * * The electric display seriously affected telegraph communication in the Northwest."

44. *Huron, S. Dak.* (90th mer.)—Auroras were observed during the late evenings of the 26th and 28th. On both nights a glow was observed in the north but streamers were seen only on the 26th, and then in the northeast.

45. *Yankton, S. Dak.* (90th mer.), August 26, 1916.—Aurora from 8:20 p. m. to 11:30 p. m. It first appeared as a whitish light in the northern sky, extending from azimuth 130° to 220° and with an elevation at its apex of about 20° . At 9 p. m. the light began to shoot toward the zenith rapidly in streamers, converging at a point about 70° above the direct northern horizon and taking on a light yellowish color. The streamers disappeared about 10 p. m., the aurora then forming an arch of light across the sky, in the same relative azimuth position first noted and with an elevation of about 40° . The arch continued until 10:45 p. m., after which time the light gradually diminished, finally disappearing at 11:30 p. m.

46. *Sioux City, Iowa* (90th mer.), August 26, 1916.—An auroral display of extreme beauty was observed from 8:30 to 11 p. m. The converging shafts of light several times almost reached a boreal crown a few degrees south of the zenith. At intervals of 20 to 30 minutes it would fade away and then gradually increase in strength until the shafts nearly reached the zenith, when waves or pulsations of light would rise like the folds of a waving flag. It was a clear white light until nearly 10:30, when it assumed a reddish tinge. Many said it was the most brilliant display ever seen here.

47. *Omaha, Nebr.* (90th mer.), August 26, 1916.—An auroral display was observed, lasting from 8:15 p. m. to after 10 p. m. There was a light like moonrise in the north, with pink on the west side and green on the east. Flickering streamers of light reached at times as high as 70° toward the zenith. The display was about 100° in width, and extended from about 130° to 230° .

48. *St. Joseph, Mo.* (90th mer.), August 26, 1916.—An aurora was observed at 8:20 p. m. and at intervals until past midnight. At 8:30 p. m. beams of light extended from a large cloud of light on the northern horizon to the vicinity of the north star. Smaller clouds of light were also noted in the northwest and northeast. Very faint illuminations, somewhat similar to distant lightning, were seen at frequent intervals shortly before midnight on the upper edge of the cloud of light on the northern horizon.

49. *Topeka, Kans.* (90th mer.), August 26, 1916.—Aurora reported on credible authority as having been seen from 11 p. m. to 11:20 p. m. At times it spread out fan-shaped in the northern sky as high as 30° and streamers were observed extending as high as 60° above the horizon.

50. *Valentine, Nebr.* (105th mer.), August 26, 1916.—A beautiful auroral display occurred to-night. It was first observed at 10 p. m. Azimuth 80° to 120° . There were a few shafts extending to near the zenith, but most of the display was in the form of bright flashes extending from the horizon to about 45° altitude. The display was faint when last observed at 10:50 p. m., and it is believed ended before midnight. The aurora probably began early in the evening, but clouds obscured the view.

51. *Miles City, Mont.* (105th mer.), August 26, 1916.—Aurora. [No description.]

52. *Havre, Mont.* (105th mer.), August 26, 1916.—The most beautiful exhibit observed here for many years prevailed to-night between 9 o'clock and 12 midnight. At 9:20 p. m. the aurora appeared with the dark segment and luminous beams of bright light of a greenish and rosy hue and also of pale yellow color appearing over that portion of the segment in the northwest, and three parallel arches extended entirely

across the sky from east to west, having a breadth of about 10° . The largest arch had its west end at azimuth of about 100° and its east end 315° , with summit 45° south of the zenith, nearly the whole sky being covered with auroral exhibit of different appearances. There were recurring fits of brilliancy and at 10 p. m. waves of light rolled up toward the zenith, luminous beams prevailed. There was no corona.

53. *Helena, Mont.* (105th mer.), August 26, 1916.—A very beautiful aurora was observed at 8:15 p. m. and it could be plainly seen until 11 p. m. The light was more intense in the western half and the pulsating streamers changed very rapidly about 9 p. m. At times the light was very strong and by proper exposure ordinary printed matter could be read. The altitude of the crown of the arch of light was about 80° and the azimuths of the extremities were approximately 110° and 210° . Cooperative observers over the State report that the aurora was the brightest observed in years.

54. *Yellowstone Park* (105th mer.), August 26, 1916.—An auroral display was noted from 8:45 p. m. to 10:15 p. m. The aurora appeared in the north with beams and streamers of yellowish light extending from the horizon to about 20° to 35° altitude. An arc of more whitish light appeared from about 45° altitude almost to the zenith. The display changed but slightly during the period it was visible.

55. *Pocatello, Idaho* (105th mer.), August 26, 1916.—Aurora. [No details given.]

56. *Modena, Utah* (105th mer.), August 26–27, 1916.—A faint aurora was observed at 10:30 p. m. of the 26th and ending during the morning of the 27th. It consisted of vibrating streamers which reached to an average height of 30° . The streamers seemed to radiate from a point below the horizon directly in the north and extended along the horizon 20° from each side of azimuth 180° .

57. *Kalispell, Mont.* (105th mer.), August 26, 1916.—An aurora was observed to-night beginning about 8:45 p. m. with a few slender streamers shooting nearly to zenith from out the northwest horizon, at which time an indistinct band of white light was noticeable extending across the sky, dimming the light of the stars forming the Big Dipper and Cassiopeia; this band prevailed about half an hour. A second band of a brighter, whiter light appeared in the course of the next half hour below Polaris, extending from the northwest to east, gradually moved upward and southward, increasing to a band of 5° in width when nearing ϵ in Scorpio well to the south of the zenith about 10 p. m. The band was brightest at the easternmost end. A few dull-white streamers began shooting up in the northwest in succession around to the east, where the brightest ones were seen, an incandescent white, tinged with red.

About 9:40 p. m. a meteor of dull yellowish white, lasting about two seconds, originated near Boötes, disappearing near the second star in the handle of the Great Dipper. Its fall as compared with the horizon was less than half a degree from the straight south-north line. There was a diminution in brightness of this meteor when passing the auroral band prevailing at the same time. It left no tail or streamer during passage.

58. *Spokane, Wash.* (120th mer.), August 26, 1916.—At 8 p. m. an aurora borealis was observed, apparently having an azimuthal extent of 135° , from 135° to 270° . No well-defined auroral arch was noted, but luminous beams, "merry dancers," intermittently flashed up from the "dark segment," frequently passing the zenith. Display disappeared before 5 a. m. observation of the 27th. Reported that telegraph wires were somewhat affected from 4:30 p. m. until midnight.

59. *Walla Walla, Wash.* (120th mer.), August 26, 1916.—An auroral display was witnessed between 8 and 10:30 p. m. A broad arc of white light extended above the horizon, its center being east of Polaris. Vertical streamers of light shot up at intervals above the bands of white light, being at times so numerous as to form a curtain of light across the northern sky. The display was quite brilliant during the first hour.

60. *Baker, Oreg.* (120th mer.), August 26, 1916.—An aurora or northern lights observed from 9 p. m. to 11 p. m., colored streamers shooting up in all directions at frequent intervals, spreading over the north, northwest, and northeast sky; lights not very brilliant.

During the display a narrow whitish arch formed at right angle at 9:45 p. m. When first observed the arch appeared to be made by or formed of small patches of cirrus clouds, which gradually formed into a well-defined arc spanning the sky from horizon to horizon; no apparent movement; arch plainly visible from 10 p. m. to 10:30 p. m., then gradually disappeared, becoming invisible by 10:45 p. m.

61. *Boise, Idaho* (105th mer.), August 26, 1916.—A singularly brilliant aurora was seen by people in the city from 9 p. m. to about midnight, but not observed by any of the regular station force. The arc was slightly colored, but the beams were white, at times reaching almost to the zenith.

62. *Seattle, Wash.* (120th mer.), August 26, 1916.—[Aurora reported. No details given.]

63. *Tacoma, Wash.* (120th mer.), August 26, 1916.—Aurora on the 26th. [No details.]

Other observations of the aurora of August 26.

Two further reports concerning this aurora gain interest from the southern latitude of the observers.

Warren, Albemarle County, Va. (lat. $37^{\circ} 45' N.$; long. $78^{\circ} 30' W.$).—There was nothing unusual between 8 and 9 p. m. (75th mer. time) on the night of August 26, but at 9:05 the sky became remarkably bright [low down and on my western horizon],³ and had the appearance of dawn, for the sky became streaked with a pale yellow glow. From [a central point of this glow] a spear of light gradually lengthened and by 9:30 p. m. it had taken the appearance of a searchlight beam. Simultaneously red lights appeared and faded [on the northwestern horizon, reaching a short distance upward and extending perhaps 2 degrees horizontally, about reaching my meridian].

At 10:15 p. m. the shaft of yellow light was unusually brilliant and began to widen, until it was as broad as the Milky Way, which it crossed. This beam became vapory and filmlike as it broadened, but when it again narrowed at 10:25 it was intensified and resumed the shape of a searchlight beam. At 10:25 it began to fade rapidly and had completely vanished by 10:30 p. m.

I was informed by neighbors that at 1 [a. m. of the 27th] the red glow [on the horizon between northwest and north] reappeared and that it seemed to fade like mist, only to spring up once again in a half dozen places to glow for several minutes and fade away once more. This last display was said to be by far the most brilliant.—*J. Churchill Newcomb, Warren, Va.*

Nassawadox, Northampton Co., Va. (lat. $37^{\circ} 30' N.$; long. $75^{\circ} 50' W.$).—Saturday evening, August 26, 1916, from 8 to 10:30 p. m. the north and northeastern [northwestern?] sky was much lighter than the rest of the sky * * * [and] with a white light * * * with streaks of the white going far up into the heavens. It was in appearance like the rays of the sun, some streaks would fade away while others would come and gradually grow lighter until they began to fade. About 9:30 p. m. a white band from 1 to $1\frac{1}{2}$ yards wide appeared across the heavens directly from west to east, going from one horizon to the other, and it was as even and direct a band as a piece of white muslin would have made.—*Mrs. Henry B. Baker, Nassawadox, Va.*

Alexandria Bay, N. Y. (lat. $44^{\circ} 20' N.$; long. $75^{\circ} 55' W.$).—This aurora illuminated the sky, between the hours of 8 and 11 p. m. (75th mer. time) in a wide area stretching from east to west, therefore bringing its center immediately overhead or in the zenith, a rather unusual feature in this section. The display consisted of irregular patches and short streamers of yellowish light of no great intensity but very rapid movement, the waves coming from the west * * *.

I feel more than ever convinced that the shapes of the cirrus clouds, especially those of the "mares' tails" variety, are in some way controlled or influenced by the forces producing the aurora. In my careful study of the short streamers and areas of light immediately overhead, to which I gave the closest attention, there was seemingly every evidence of this control. At times these areas would take on the exact form of the twisted plumes and combed-out cirrus, so much so that for a very few moments one would wonder if it were not cirrus that he was gazing at; but in a second or two this [appearance] would die out, leaving the black, starlit sky.

It was also clear, from watching the streamers right overhead, that a great deal of [their] uniformity was due to perspective, for in the area [overhead] they lost their pencil or searchlight effect, but nearer the horizon it was gained again * * *.—*Douglas Manning, Alexandria Bay, N. Y.*

York, N. Y. (lat. $42^{\circ} 52' N.$; long. $77^{\circ} 53' W.$).—Streamers, rising over half way to the zenith, were noticed about 8 p. m. (75th mer. time). The sky was partly clouded, especially in the north. As a background to the clouds, the aurora lit up the whole north with a curtain of white light. An arch about 15° in height, with its center west of north, was seen as soon as the clouds moved away. At 8:10 a bright spot, perhaps 10° in diameter, was seen nearly due south at an altitude of approximately 35° ; it moved slowly westward and was hidden under clouds moving from west-northwest. A few minutes later luminous, cloud-like streamers were noticed in the east. These moved southward and depended, like fracto-nimbus clouds, from the lower side of a C. C. U. band extending across the northeast. By 8:45 the arch in the north had nearly doubled in height, while pulsating streamers from northeast to west reached two-thirds of the way to the zenith. Silent lightning was seen at intervals in the south and southeast from 8 to 8:40.

At 9:40 p. m. the aurora was the brightest. Streamers from west to east-northeast met about an open, dark space southeast of the zenith. Before their greatest height was attained light rolled up in waves and at other times like the rays of a searchlight. Soon after the corona was formed the streamers died away and had disappeared by 10 p. m. Clouds, unnoticed during the illumination, then covered the whole sky; their direction appeared to be from the southwest. The tempera-

ture was 74° at 6 p. m. The barometer remained steady during the night at 29.22 inches (uncorrected). Rain began in the night and continued at intervals till 11:30 a. m. of the 27th, 0.28 inch falling.—*Milroy N. Stewart, York, N. Y.*

Aurora of August 26, 1916, at Bristol, England.⁴

A fine exhibition of aurora borealis was observed by Mr. W. F. Denning at Bristol [lat. $51^{\circ} 27' N.$, long. $2^{\circ} 35' W.$, approx.] in the early morning of Sunday August 27, between the hours of 2 and 4 G. M. T. [i. e. between 9 and 11 p. m., Saturday, August 26, 75th meridian Time]. Shafts of light were first observed at about $2^h 15^m$ [$9^h 15^m$ p. m., Aug. 26, 75th m. t.] ascending among the stars of Ursa Major and Draco, and reaching considerable altitudes. Changes affected the appearances at short intervals, the streamers would fade away and new ones form, while the invariable disposition of the whole was to move quickly from the west to the east side of the north point. Some of the more conspicuous streamers were particularly recorded as they passed over certain stars, and the mean rate of motion across Ursa Major was found to be 15° in three minutes.

The active region seemed to extend from as nearly as possible NW. to NE., but the NW. and N. showed the greatest abundance of streamers; in the NNE. there was a succession of faint bands of light rising upward to the left of Auriga. Many of the rays observed in the N. region could be faintly traced to altitudes of 70° . The phenomenon was watched until $3^h 45^m$ [$10^h 45^m$ p. m., Aug. 26, 75th m. t.], when the sky had regained its normal appearance, and twilight had become strong in the northeast.

OTHER AURORAS DURING AUGUST, 1916.

The following extracts from the August, 1916, journals of Weather Bureau stations show where and when auroras were observed in the United States between August 1 and 25, inclusive, and on the 28th and 29th:

Auroras of August 1 to 25.

Ludington, Mich. (90th mer.), August 1, 1916.—An aurora was observed at 11:30 p. m. Its beginning was not observed. It probably continued to midnight or later. The display consisted of a long, low, whitish arch with altitude of the summit about 20° and azimuth 135° to 225° .

Houghton, Mich. (90th mer.), August 2, 1916.—Aurora observed to-night, but was not noteworthy.

Bismarck, N. Dak. (90th mer.), August 2, 1916.—Aurora observed at 10:30 p. m. [No data given.]

Alpena, Mich. (90th mer.), August 5, 1916.—Aurora observed; only an ill-defined glow of light along the northern horizon.

August 19, 1916.—The aurora when first observed at 7:50 p. m. consisted of an arch above the northern horizon, 20° altitude, azimuth 125° to 235° . Streamers, which varied constantly and rose to 40° altitude, developed at 9:20 p. m. By 9:30 p. m. the arch had broken up. Isolated streamers were observed at intervals until late at night.

Duluth, Minn. (90th mer.), August 19, 1916.—Rather brilliant aurora, azimuth 215° to about 250° , observed from 9 p. m. to some time after 10 p. m. Its color was the usual greenish-white with bright perpendicular shafts that reached an altitude of about 45° .

Devils Lake, Wis. (90th mer.), August 19, 1916.—Auroral display recorded on the 19th was small, the arch being about 18° in altitude and its azimuth, from 140° to 170° . Underneath the arch was darkness, while above there was considerable light of pale greenish color. No long streamers or bands of light were observed. The display was observed at 10:30 p. m.

Grand Forks, N. Dak. (90th mer.), August 20, 1916.—Aurora on August 20. [No data given.]

Alpena, Mich. (90th mer.), August 22, 1916.—Aurora observed; only an ill-defined glow along the northern horizon.

³ Remarks in [] are added from a rough diagram submitted by our correspondent but not reproduced.—C. A., Jr.

⁴ "Nature," London, Aug. 31, 1916, No. 2144, 97:551.

Aurora of August 28, 1916.

The brilliant aurora of August 26-27 was followed by another unusually bright display on the night of the 28th; but the available reports at present scarcely justify the conclusion that the disturbance which began on the 26th was really continuous through into the night of the 28th and even the 29th (see Canton, N. Y., Aug. 29, below).

Boston, Mass. (75th mer.), August 28, 1916.—Aurora was reported to have occurred on the night of the 28th, but was not observed at the station by reason of artificial illumination in the city.

New Haven, Conn. (75th mer.), August 28, 1916.—Aurora borealis observed 10:45 p. m. to 11 p. m.; not bright; a glow on the northern horizon with faint rays or streamers little more than suggested at intervals.

Canton, N. Y. (75th mer.), August 28, 1916.—Auroral arch north to northeast, 9 to 11:30 p. m. Altitude 15°. Occasional streamers, altitude 40° to 45°.

York, N. Y. (lat. 42° 52' N.; long. 77° 53' W.; 75th mer.), August 28, 1916.—Arch and streamers first noticed about 10 p. m. Streamers did not last long, but arch remained for more than an hour. At 10:25 p. m. several parallel, luminous bands, about 15° in height, were seen above Ursa Major. They appeared perpendicular to a line joining the stars Benetnasch and Alcor, and extended eastward as far as the Milky Way. The bases of these bands were about half way from the horizon to the zenith; their width increased somewhat toward the east. At irregular intervals part of the arch on the horizon would become brighter; this luminous spot would move westward; then the parallel bands, which, perhaps, had almost disappeared, would shine with renewed brilliance and continue to do so after the arch had resumed its steady glow. At no time were these bands connected with the arch, nor did they greatly increase their length toward the zenith. They were last noted at 11:15, after which they gradually faded out—the arch remaining till after 11:40. Barometer 29.44 (uncorrected); temperature 65°. No rain followed.—*Milroy N. Stewart, cooperative observer.*

Alpena, Mich. (90th mer.), August 28, 1916.—Aurora observed; only an illdefined glow of light along the northern horizon.

Ludington, Mich. (90th mer.), August 28, 1916.—Aurora from about 8:15 p. m. to about midnight. A broken arch, with altitude of summit 25° to 30°, and azimuth 150° to 210°, was present from 8:30 p. m. to 9 p. m. There were some streamers with it. Between 9 and 10 o'clock there were two arches, about 10° apart with a dark band between them. The altitude of the outer arch was 30° and the azimuth 145° to 235°. Streamers radiated upward from it. There was some flashing at 10 p. m.

Escanaba, Mich. (90th mer.), August 28, 1916.—An auroral display was observed at 8:20 p. m. The phenomenon consisted of a well-defined arch of about 10° in altitude and about 140° to 220° in azimuth across the northern horizon. A few varying and occasional streamers were observed, none reaching an altitude of more than 60°. The light was of a greenish tint. The phenomenon continued quite late, when it was reported the streamers, one in particular, became very bright. It was not under the observation of the observer after about 9 p. m.

Houghton, Mich. (90th mer.), August 28, 1916.—Aurora was observed to-night but was not noteworthy.

Duluth, Minn. (90th mer.), August 28, 1916.—Very brilliant aurora observed between 9 and 10 p. m., azimuth 110° to 230°. Altitude of highest greenish-white shafts of light about 60°. At 9:25 p. m. there was a shaft of bright light about 5° wide at the widest portion and extending from near the horizon at azimuth 243° across the zenith to about the horizon at azimuth 68°.

Huron, S. Dak. (90th mer.), August 28, 1916.—[During the late evening an auroral glow was observed in the north.]

Bismarck (90th mer.), August 28, 1916.—Faint aurora observed at 9:30 p. m.

Williston (90th mer.), August 28, 1916.—An aurora was observed from 9:20 p. m. to 10:25 p. m., extending in azimuth from 160° to 225°; a faint arch was first seen resting upon a dark segment, which rose to an altitude of about 15°; at intervals a few streamers of a dull whitish color appeared, some of which reached an altitude of about 30°; the dark segment began to disappear about 10:05 p. m., and by 10:25 the aurora was no longer visible.

Aurora of August 29, 1916.

Canton, N. Y. (75th mer.), August 29, 1916.—Faint auroral arch, altitude 12°, observed 10 p. m.